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P.O. Box 1389
Cortez, Colorado 81321
February 16, 2005

Mr. Don Metzler
Moab Federal Project Director
U.S. Department of Energy
2597 B ¾ Road
Grand Junction, Colorado 81503

Subject: Remediation of the Moab Uranium Mill Tailings
DOE/EIS-0355D

Dear Mr. Metzler:

The purpose of this letter is to present my reasons for opposition against three of the proposed alternatives and my reasons in favor of either of two alternatives.

I am opposed to On-Site Disposal, utilization of the White Mesa Mill Site and a No-Action alternative. The tailings pile must be moved. Everyone aware of the pile's existence has known this for many years as evidenced by the DOE's thorough analysis and documentation as presented in your Draft EIS. The tailings are much, much too close to the Colorado River. Consequently, they pose an unacceptable long term risk to the downstream environment and users of the river's resources in terms of on-going leaking and leaching of contaminants and in terms of the chances for a shift in the river channel, either slowly over time or suddenly, with catastrophic consequences. Finally, and not an insignificant consideration, is the long-term health effects on the residents of Moab and the Grand Valley from wind-blown dust and particles from the pile, despite the best efforts to prevent this with proper cap maintenance.

I am opposed to the White Mesa Mill Site Alternative primarily because of the long distance transport of tailings this requires. First the considerable distance involved as compared to the two other off-site disposal alternatives immediately makes White Mesa relatively less favorable. Secondly, the terrain between the pile's present location and White Mesa is not conducive to transport of such a hazardous material. Whether by highway or slurry pipeline, this rugged country of sharp hills, canyons, and rock monoliths makes this alternative a choice of "last resort" from a transport consideration. As a civil engineer, I can envision the detailed engineering required to construct and safely operate a slurry pipeline through this area. It can be done but at a great cost in route surveying, engineering design,

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right of way acquisition and construction and maintenance. Operational costs of transport and the costs associated with recycling the water and returning it to Grand County are further factors against this alternative. There are a number of points to consider with regards to use of the existing highway for truck transport, all reasons for not choosing this alternative. The present highway is well designed and accommodating of the topographic hurdles it must overcome. Nonetheless, the chances of an accident and spillage or loss of tailings material is greater on this highway than it would be on a highway having a more uniform grade and a more linear alignment.

I am a frequent user of this highway both on business and for access to recreation areas. I have an engineering office in Cortez, Colorado, a branch office in Monticello, Utah and business dealings in Moab and Blanding. I have traveled this highway between Blanding and Moab in all weather and all times of the day. The highway is heavily used by trucks, recreation vehicles and passenger cars. It would not be wise to increase this traffic loading with the transport of the mill tailings to White Mesa. I am sure you are well aware of the traffic through the city of Moab with predictions approaching 1000 trucks per day without the addition of tailings transport. There is no reasonable bypass route around downtown Moab. Likewise, for Monticello and Blanding, these two cities should not suffer the consequences of tailing truck traffic. And although it is conceivable that bypasses could be built around each city, the associated costs, both in construction and in lost revenue for city businesses from tourists and others not going through the downtown commercial area eliminates this from consideration. In summary, given that there are other, more viable alternatives, there is no justification for hauling the tailings by truck to White Mesa.

Finally, with regards to the While Mesa alternate, it is not proper to burden the residents of this area with the potential hazards associated with relocating the tailings pile there.

I am I favor of either of the two Grand County alternatives, either disposal at Klondike Flats or at Crescent Junction. The big advantage of both of these two alternatives is their close proximity and relative ease of access by-means-of rail transport. I understand one of the objections to the Klondike Flats Alternate is its heavy use by bikers. Loss of a recreational feature that can be replicated elsewhere in Utah is an invalid reason for not considering this site when other factors such as geology, topography and hydrology are of much more importance.

I also encourage you to institute an active and comprehensive groundwater remediation system at the site of the tailings pile employing the latest "pump and treat" technology.

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In summary, Klondike Flats Alternate and Crescent Junction are the two most favorable alternatives. The White Mesa Mill Site is the least favorable due to all the transportation factors associated with it.

Thank you and your staff for all of your efforts and for this opportunity to comment on the draft EIS.

Yours truly,

Richard A. Stafford

Richard A. Stafford, P.E.

Document #429 Dohrenwend, John C. University of Arizona

Cathy Thomas

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From: dohrenwend@scinternet.net
Sent: Thursday, February 17, 2005 1:08 PM
To: moabcomments
Subject: Technical comments re: river migration potential

MoabMillComment.doc

Attached are my comments regarding the potential for river migration in the vicinity of the Moab Mill site. Comments are in MS word format.

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Review of the Department of Energy's Assessment of Potential Flood Hazards at the Moab Project Site (Atlas Tailings Pile)

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Introduction

For almost 25 years, the city of Moab, Grand County and the state of Utah have all been faced with a difficult and contentious problem: what to do with the uranium mill tailings pile located on the Colorado River floodplain just north of town? This problem is complex and contentious. On the one hand, an impressive number of scientists and engineers working for Atlas Minerals Corporation, the Nuclear Regulatory Commission, and the Department of Energy have written reports suggesting that the pile is safe and will not be compromised by even the largest of floods that could possibly occur in the area. But common sense suggests that the location of the pile just isn't safe. After all, the Colorado River is notorious for the extreme variability of its flows. Flows in historic times have ranged from base flows of 2500 to 4000 cfs during the dry months of late summer, fall and winter to as much as 125,000 cfs during the snowmelt floods of late spring and early summer. Moreover, the site of the mill and tailings pile is located on the Colorado River floodplain on the outside of a large bend in the river channel.

The potential impact of an extreme flood is considered by many people to be one of the key issues relating to the safety of the mill site. However this possibility is not adequately considered in the draft EIS on 'Remediation of the Moab Uranium Mill Tailings' released by the Department of Energy on November 3, 2004. Instead, limited references are made to four previous reports that discount flooding as a serious problem. These reports are:

Harvey, M. D. and Schumm, S. A., 1982, Geomorphic Evaluation of the Long Term Stability of the Below-Grade Disposal System Site, Atlas Minerals Uranium Extraction Facilities, Moab, Utah: Water Engineering and Technology, Inc., Shreveport, Louisiana, unpublished report, 30 p.

Mussetter, R. A., and Harvey, M.D., 1994, Geomorphic, hydraulic and lateral migration characteristics of the Colorado River, Moab, Utah - Final Report: Mussetter Engineering, Inc., Ft. Collins, Colorado, unpublished report to Canonie Environmental and Atlas Corporation (MEI Ref. No, 94-02), 102 p.

U. S. Department of Energy (Grand Junction Office), 2002, Lithologic, Well Construction and Field Sampling Results from the 2002 Field Investigation: Report October 2002,, 60 p.

U. S. Department of Energy (Grand Junction Office), 2003, Migration potential of the Colorado River channel adjacent to the Moab Project site: Letter Report November 2003, Revision 2, 11 p. + Figures

The last of these reports draws heavily from the data and interpretations presented in the previous reports and summarizes the position of the DOE regarding the flood hazard potential at the Moab Mill site, This 19 page document claims that, "Although a conclusive prediction of future river movement is not possible, evidence suggests that the river is and will continue migrating to the south and east away from the existing tailings pile." The report presents several technical arguments in support of this claim.

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These arguments include consideration of:
(1) Historical evidence of river migration,
(2) Sediment input from Courthouse Wash and Moab Wash,
(3) Location and age of river terrace gravels at the north end of Moab Valley
(4) Thickness and distribution of basin-fill sediments in the Moab Valley,
(5) Rate and character of salt dissolution in the Moab Valley area, and
(6) Absence of a cobble-gravel bedload downstream of the Portal.

Historical evidence of river migration

Because of the potential impact of an extreme flood on the stability of the Atlas tailings pile, the Colorado River and its floodplain between the US 191 bridge and the Portal has become one of the most intensively studied areas in the upper Colorado river basin. This area has been measured, modeled, drilled and sampled throughout the past two decades in an effort to predict future changes in the river's channel. Historic maps, aerial photos and satellite images have been examined to document changes in channel form and position over the past 80 years.

According to the analysis included in the November 2003 letter report, the Colorado River is moving south and east towards Moab. However, this is highly unlikely because Moab is on the inside of a river bend aimed away from town. In fact the historical analysis presented in this DOE report is seriously flawed. Several of the maps and aerial photographs used in this analysis were not accurately registered to each other. These inaccuracies are most conspicuous for the DOE interpreted positions of the channel in 1944 and 1953. Downriver from the pile, the southwest bank of the river is shown in the DOE analysis to be located in 1944 and in 1953 near the present position of the river's northeast bank. Also conspicuously inconsistent are the different channel positions attributed to 1953 (based on aerial photos) and 1959 (based on the 1959 USGS topographic map). This is particularly revealing because the 1959 topographic map was produced from analysis of the 1953 photos.

By accurately registering all the historic maps and photographs, reliable comparisons between one time and another can be made, and the picture summarized in Figure 1 emerges clearly. Since 1924, the south and east bank (river left) has moved progressively north, west and southwest away from Moab. From the bridge to the pile, the south bank has moved north and northwest an average of 320 feet since 1944. Downstream from the pile, this bank has moved west and southwest an average of 175 feet during this same period. In contrast, most of the north and west bank (river right) has remained in essentially the same position since 1924. The only significant exception is the area immediately adjacent to the pile where the channel appears relatively unstable. In this area, the west bank shifted rapidly eastward between 1962 and 1983, only to shift westward again sometime before 2001. The net result of all of these changes has been a conspicuous 37% narrowing of the channel that occurred mostly between 1962 and 1983.

These findings are directly contrary to the statement in the November 2003 letter report that " the river is and will continue migrating to the south and east away from the existing tailings pile" and they cast considerable doubt on the overall integrity of this report. Moreover, the progressive narrowing of the channel between 1944 and the

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present implies that the river's past behavior may not be a reliable predictor of future channel changes.

Sediment input from Courthouse Wash and Moab Wash

According to the November 2003 letter report "The tailings pile and former mill site are sited on an alluvial fan developed from Moab Wash and Courthouse Wash. Both washes have delivered significant quantities of sediment to the area in the past, and deposition will continue unless significant changes occur in the upstream watersheds. Sediment input from Courthouse Wash and Moab Wash tends to push the river south and prevents lateral migration to the north".

However, as inspection of historical aerial photographs clearly shows, the Colorado River channel has, in fact, moved more than 300 feet north and northwestward between 1944 and the present time (Figure 1). In direct contradiction to DOE's argument, most of this movement occurred directly opposite and immediately downstream from the mouth of Courthouse Wash.

It has long been recognized that the alluvial fans of desert streams typically build outwards from their valley (or canyon) mouths. However in some important ways, Courthouse Wash is not a typical desert stream. It joins the Colorado River less than a quarter mile after leaving the mouth of its narrow, steep-walled canyon. During low flows, the much larger flow of the Colorado quickly carries away most of the sediment that might otherwise be deposited at the mouth of the wash. During high flows a very different situation may occur.

Like many of the washes that drain the slickrock country in the Moab area, Courthouse Wash is ephemeral and its flow is highly variable. The wash seldom flows with any volume for more than a few days, even after a heavy rain. Flash flooding is common and typically occurs during the southwest monsoon in mid to late summer. During flash floods, flows down the wash may exceed several thousand cubic feet per second (cfs), and in extreme cases, may peak at flows greater than 10,000 cfs.

Most of the water flowing down the Colorado River comes from the snowfields of the southern Rocky Mountains. Consequently, the highest flows on the river almost always occur during the snowmelt floods of late spring. By mid summer, flow in the river typically drops to somewhere between 2500 and 4000 cfs. Therefore, whenever a large flash flood occurs on a tributary wash, the result is that for a short time the flow of the tributary exceeds the flow of the main stream. When this happens, the tributary flow may jet all the way across the main stream channel to the opposite bank.

This unusual role reversal between tributary and main stream can be truly spectacular. For example, consider this eye witness account of an event which occurred near the downstream end of Westwater Canyon in the late summer of 2002 when washes started running red over the black rocks of the canyon's walls. "At the end of the rapids and around the corner, a side canyon at Big Hole was spewing water, rocks and debris across the river and effectively preventing the rafts from passing the side canyon. The flow from the side canyon had enough force to shower the rafters upstream with a rain of mud."

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Courthouse Wash has been witnessed to behave in a similar fashion during late summer floods, shooting water and debris across the Colorado and sometimes into the sloughs. First-hand observations of the effects of a powerful flash flood on Courthouse Wash in the mid 60's provide insight into the effect of such floods The alluvial fan deposited by this flood was large enough to temporarily block and divert the flow of the Colorado River. This incident is a compelling demonstration of the possible short-term dominance of the wash during the summer monsoon season, when the river is low.

This role reversal has contributed to the accumulation of large quantities of sediment along the south bank of the Colorado River directly opposite and immediately downstream from the mouth of the wash. This, in turn, has contributed to the northward migration of the south bank and a significant narrowing of the river channel.

Location and age of river terrace gravels at the north end of Moab Valley

River gravels are exposed on a strath terrace surface at the mouth of Courtwash Wash. This terrace surface is an erosional feature cut in bedrock. The elevation of this terrace is about 4012 feet, approximately 54 feet above the present level of the Colorado River channel (Figure 2). The age of this terrace has been estimated to be about 12,000 to 30,000 years old. This age estimate is based on a comparative analysis of soil development. However, the terrace surface is significantly degraded. Therefore, this age estimate should be considered as very imprecise and is probably much too young.

The November 2003 letter report argues that the location and estimated age of this terrace suggests that the river has migrated southward over the last 12,000 to 30,000 years. However, there are two significant problems with this suggestion:

(1) This terrace is located within the mouth of Courthouse Wash and, therefore, is more a product of Courthouse Wash than the Colorado River. Colorado river gravels are preserved on the terrace surface. However, these gravels could have been deposited during a large flood on the Colorado River, and therefore, they do not necessarily indicate the exact position of the Colorado River channel at the time of deposition.

(2) Assuming the age estimate based on relative soil development is correct, the height of this terrace would suggest that the Colorado River has been downcutting at a rate somewhere between 4.5 and 1.8 feet per thousand years during the past 12,000 to 30,000 years. This is the only terrace on the Colorado River that is preserved in Moab Valley. However, preliminary age estimates based on exposure age dating techniques upstream from Moab Valley indicate downcutting rates more on the order of 0.7 feet per thousand years. If this estimate is correct, then the age of the Courthouse Wash terrace would be closer to 75 thousand years

A wood sample was recovered from DOE borehole 435 at an elevation of about 3853 feet, approximately 105 feet below the level of the present river channel. Bore hole 435 is located about 600 feet from bedrock outcrop at the north end of Moab Valley and about 1200 feet from the terrace at the mouth of Courthouse Wash (Figure 2). The age of the wood sample has been estimated by radiocarbon analysis to be about 45,000 years old. Unfortunately, reliable radiocarbon age dating is limited to the last 45,000 years.

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Therefore, this age estimate must also be considered to be very imprecise. That is, the age of this sample must be considered to be 45,000 years or older, and exactly how much older cannot be determined by radiocarbon analysis.

If one assumes that these two age estimates are both precise and correct, then these two occurrences suggest either: (1) a minimum of 159 feet of displacement between the mouth of Courthouse Wash and the site of bore hole 435 within the past 45,000 years; or (2) extremely deep scour by the Colorado River sometime during the past 45,000 years at this location - and very likely on through the center of the site of the Atlas tailings pile.

Of more significance is the fact that similar river gravels are widely distributed beneath the surface of Moab Valley (Figure 3) demonstrating that the Colorado River channel has, in the past, flowed directly through the site of the tailings pile.

None of these observations indicate a unidirectional migration of the Colorado River channel. However, they do prove that the Colorado River has flowed through the site in the past and they suggest the possibility of either significant subsurface instability or extreme channel scour at sometime during the recent geologic past.

Thickness and distribution of basin-fill sediments in the Moab Valley

The reports cited in the DEIS to substantiate the contention that the Colorado River is moving away from the tailings pile have not reported or considered all available data regarding the thickness and distribution of valley filling deposits in the Moab valley.

For example, the data developed by the groundwater studies of Gardner and Solomon and the results of subsurface investigations conducted by the Department of Energy in 2002 have not been consistently or carefully considered in DOE's subsequent reports. Specifically, the thickness and distribution of valley fill deposits beneath the tailings pile and mill site are certainly much more complex than reported in the November 2003 letter report. Figure 8 of this report (NE-SW Diagrammatic Cross Section, copied from Doelling et.al., 2002) does not include any of these data and shows only a very simplistic interpretation of the thickness and distribution of the valley fill. Yet no attempt has been made to correct this interpretation to show the implications of the additional borehole data. Also, the November 2003 letter report neglected to mention Doelling's cautionary note regarding his cross section. "The exact position or trend of this fault (?) is unknown. In fact it may not be a fault at all, but a dramatic thinning of units northwest of the bend in the Colorado River". Moreover, Gardner and Solomon's bore hole data for areas south and east of the river are not included in Figure 4 (Estimated Top of Gravel Surface) or Figure 5 (Approximate Quaternary Sand Thickness).

When all of the data are compiled, what they actually show is that the subsurface conditions directly beneath the tailings pile are much more complex than the highly simplistic and relatively benign picture presented by the November 2003 letter report. Indeed, these data indicate that localized subsidence of the valley floor directly beneath the tailings pile must be considered as a possible and potentially serious geologic hazard.

Moreover, available well log and bore hole data indicate that the valley fill is not thickest and deepest south of the present location of the river channel. Rather, these data

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show that the valley fill is thickest and deepest beneath or perhaps as much as several hundred feet north of the present river channel. Consequently, the position of 'The Sloughs' in the Matheson Wetlands is not directly related to salt induced subsidence of the valley filling sediments. Instead, 'The Sloughs' merely mark the lowland boundary between the Mill Creek-Pack Creek fan and the Colorado River fan. Therefore, even if the relatively slow subsurface subsidence of Moab Valley were to affect the valley's surface, there is no reason to suppose that continuing subsidence of the valley floor would cause the river channel to migrate away from the tailings pile. Indeed, if one assumes that the thickest and deepest valley fill deposits mark the position of maximum valley subsidence, then there would be, in actual fact, strong reason to suppose that continuing subsurfasce subsidence could cause the river to move closer the pile.

Rate and character of salt dissolution in the Moab Valley area

Recent measurements of the ages of the isolated remnants of multiple paleosurfaces, using cosmogenic isotopic dating techniques, have determined that even some of the highest mesa surfaces between Capitol Reef and Caineville Reef (west of Moab Valley and south of the San Rafael Swell) are little more than one million years old. All of the buttes, monuments, ridges, and canyons below these mesa tops have been formed by erosional processes during the past one million years. When this information is put into the context of the results of other geologic research, including radiometric age measurements of the volcanic caprock on Grand Mesa (about 6 million years old) and the igneous dikes in Cathedral Valley (about 4 million years old), these findings enable the compilation of a much more precise history of the erosional history of the Colorado Plateau.

The area of the central Colorado Plateau (and Moab Valley) has been subjected to more or less continuous erosion during the past 5 to 6 million years. During this time, the rocks and sediments that once covered the region to the tops of today's highest mountains have been eroding away at an average rate approaching one foot per thousand years. By comparison, average erosion rates in many areas of the American Southwest are only one or two inches per thousand years. The Colorado Plateau is, therefore, one of the youngest, most rapidly changing landscapes in all of North America, and the principal agent of all of this erosion is, of course, the Colorado River system.

The Moab Valley is the surface expression of a collapsing salt-cored anticline. The salt beds beneath the valley's subsiding floor are almost 2 miles thick. As the Colorado River and its tributaries cut down through the thousands of feet of rock that once covered this salt-cored anticline, tremendous volumes of rock were removed and the land surface gradually lowered. Eventually, probably sometime about two million years ago, circulating groundwater reached the level of the uppermost salt beds. As the salt dissolved, the crest of the anticline began to collapse forming the Moab Valley. As the river continues cut down through the plateau, the valley continues to subside.

The rates of valley subsidence and river downcutting are closely related. Most of the groundwater beneath the valley surface is a dense salt brine. As the river continues to downcut, fresh near-surface groundwater continues to mix with the brine promoting continued dissolution of the salt. Thus it is the River's downcutting that controls the

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erosional evolution of the Colorado Plateau and all of its component parts, including Moab Valley and the site of the Atlas tailings pile.

Absence of a cobble-gravel bedload downstream of the Portal

The November 2003 letter report regarding the potential flood hazard at the Atlas tailings pile observes that large gravels and cobbles are not found in the active river channel downstream of the Portal, except near side canyons. This report also maintains that the surface of Moab Valley is subsiding, and that because of this subsidence, coarse river sediments are being trapped in the valley. This reasoning is used to suggest that continuing subsidence will force the Colorado River channel to migrate south and east, away from the Atlas tailings pile and towards Moab.

Groundwater dissolving the massive salt layers far beneath the valley floor is, in fact, causing the slow subsidence of the valley's alluvial fill. But, the surface of Moab Valley is not dropping because of this subsidence. The Colorado River and its local tributaries deliver far more sediment to the valley floor than could ever be accommodated by the valley's slow subsidence. Therefore, ongoing deposition by the Colorado River and by Mill Creek and Pack Creek are the principal processes controlling the surficial geology and geomorphology of Moab Valley.

The correct explanation for the lack of cobbles and gravels in the active channel downstream from the Portal is quite different.

Of course, the steepness of a riverbed plays a central role in a river's ability to move sediment. Other things being equal, the flatter a river's slope - the smaller the size of the bedload sediment it can move. From Moab Valley all the way downstream to Cataract Canyon, the average slope of the river is very low, averaging only 15 inches per mile (0.025%). In contrast, the river gradient upstream from Moab Valley (between Dewey Bridge and Negro Bill Canyon) drops an average of five feet per mile (about 0.1%), and downstream in Cataract Canyon, the average drop is almost 12.5 feet per mile (0.25%). Therefore, channel sediments in and downstream of Moab Valley are mostly fine grained. Cobbles and other coarse materials are only moved during large floods. At all other times, only fine sediments are moved through this flat water section.

The sequence of fine-grained deposits overlying coarse-grained deposits is typical of many late Quaternary (less than 50,000-year-old) valley fill sequences in the Southwest. Generally speaking, the gravels were mostly deposited during late glacial times when precipitation was greater and river flows were larger (and/or very large floods were more frequent). The finer grained sediments were deposited during post-glacial (Holocene) times when precipitation was less (and/or very large floods were less frequent). This change in the grain size of alluvial deposits is typically most pronounced in those areas where river gradients are relatively low. Other things being equal, alluvial deposits in low gradient areas are a more sensitive indicator of changes in river flow. This is because declining river flows will first lose their ability to carry larger, heavier bed load materials in low-gradient (low-energy) river reaches. The result is the typical alluvial fill sequence where glacial age river gravels are overlain by post-glacial age river sands.

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Summary

The suitability of Atlas mill and tailings site for the long term disposal of hazardous waste has not been established by the November 2004 DEIS. The site was not originally selected out of concerns for human health and safety or for the preservation of environmental quality. Rather it was selected as a convenient place for the milling of uranium ore and a cheap place for dumping the enormous quantities of chemical and radioactive waste generated by that milling process. Therefore, there is no a priori reason to suppose that the site is suitable for long term waste disposal.

Analyses of the November 2004 DEIS and supporting reports clearly show that these documents do not present a realistic picture of the geologic and hydrologic conditions at the Atlas mill and tailings site. Careful and consistent analyses of available scientific data concerning the suitability of the site must be made within the context of accurate perceptions of how the Colorado River really interacts with the Moab Valley. Such analyses clearly show that the flood hazard potential at the Atlas tailings site is not diminishing, as the reports cited by the DEIS claim, because of a theorized southward and eastward migration of the Colorado River. Rather, the River has flowed across the tailings site in the past and very possibly could return to that course in the future. Furthermore, because the River's inner channel has, over the past 80 years, shifted closer to the pile and has become narrower and deeper, the potential for deep channel scour, sudden channel shifting, and catastrophic failure of the pile during large floods may well have increased significantly.

Contrary to the claims and speculations contained in the reports used by the DOE to support the inferences and conclusions presented in the DEIS, the following points are clear:

(1) An 80-year history documented by accurate registration of historic maps and aerial photographs clearly shows that the Colorado River is not migrating south and east away from the tailings pile. The high flood levees bordering the main channel have not shifted measurably. However, the south and east bank of the active channel between these levees has moved north and west, and it is now 150 to 300 feet closer to the mill site. And, the channel has narrowed and deepened in its new position.

(2) Courthouse Wash and Moab Wash have not caused the Colorado River channel to migrate away from the mill site. Rather, analysis and direct observation of high energy flows from Courthouse Wash demonstrate unquestionably that these floods have deposited sediments on the south side of the Colorado River channel, and therefore, have actively contributed to the northward migration of the river channel

(3) Available well log and bore hole data indicate that the valley fill is not thickest and deepest south of the present location of the river channel. Rather, these data show that the valley fill is thickest and deepest beneath or perhaps as much as several hundred feet north of the present river channel. Therefore, there is no reason to suppose that continuing subsidence of the valley floor would cause the river channel to migrate away from the tailings pile. Indeed, if the thickest and deepest valley fill deposits mark the position of maximum valley subsidence, the there would instead be strong reason to suppose that continuing subsidence could cause the river to move closer the pile.

(4) Available subsurface data also show that conditions directly beneath the tailings pile are much more complex than the highly simplistic and relatively benign picture

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presented by the DOE. Indeed, these data indicate that localized subsidence of the valley floor directly beneath the tailings pile must be considered as a possible and potentially serious geologic hazard. Moreover, comparison of surface and subsurface data along the northern margin of Moab Valley between Courthouse Wash and the mill site suggest the possibility that localized subsidence or extremely deep channel scour has occurred in this area sometime during the past 45,000 years.

(5) Although dissolution of the massive salt layers beneath Moab Valley is causing the slow subsidence of the alluvial fill within the valley, the valley's surface is not dropping because of this subsurface subsidence. The Colorado River and its local tributaries deliver far more sediment to the valley floor than could ever be accommodated by the valley's slow subsidence. Therefore, ongoing deposition by the Colorado River and by Mill Creek and Pack Creek are the principal processes controlling the surficial geology and geomorphology of Moab Valley.

(6) Finally, the geometry and position of ancient Colorado River gravels buried beneath the surface of Moab Valley clearly show that the Colorado River has in fact shifted back and forth across mill and tailings site in the recent geologic past.

In summary, there is considerable scientific evidence that important flaws exist in those studies indicating suitability of the Moab mill site for the long-term storage of hazardous waste. Particularly flawed is the contention that the Colorado River is presently and will continue to migrate away from the site. This contention is completely incorrect. The Colorado River channel is has not migrated south and east away from the Moab Mill site at any time in the past 80 years, and there is no reason to suppose that it will start to do so at any time in the immediate future.

Additional scientific study

Additional scientific studies focused on the potential flood hazard at the Moab Mill are needed to determine whether the site is a suitable place for the long term disposal of uranium mill waste. To be useful additional studies must significantly reduce the uncertainties that surround and confound our understanding of the complex relationship between the Colorado River and the Atlas tailings site. Specifically, such studies should determine whether or not there is significant potential for catastrophic flooding that could compromise the stability and integrity of the tailings pile. They should also address the uncertainties related to the downstream impacts of such an event.

The Moab Valley is a very unusual place – essentially one of a kind on the Colorado Plateau, in North America, and perhaps anywhere in the world. The formation of the Moab Valley is in large part the result of salt tectonics. The folding, flow, and diapiric rise of massive salt deposits from far beneath the earth's surface, and the dissolution of these deposits as the earth's surface is eroded down to the level of the rising salt are the principal processes that have shaped most of the large valleys of the Paradox Basin. And of all of these breached anticlinal valleys, the Moab Valley appears to be the only one where the Colorado River or any of its tributaries are downcutting more slowly than the valley is subsiding. This, in and of itself, makes the Moab Valley practically unique.

Moreover, the valley is located in the east central part of the Colorado Plateau, a region of very rapid erosion and landscape change. This part of the Plateau is one of the

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youngest landscapes in North America. And as the principal agent of this rapid erosion, the Colorado River is quite literally one of the dirtiest rivers in the world. That is to say, it carries more dirt or sediment per unit of flow than all but a few of the world's major rivers.

There is probably no other place on earth that is truly comparable to the Moab Valley. This makes the scientific study of this very unusual place all the more difficult. Earth science works best when there are many places where similar phenomena and relationships can be used for comparison with the area being studied Without the ability to make such comparisons, it is very difficult to test or verify the results and conclusions of the study.

Further complicating the issue is the fact that recent geologic times have been and continue to be times of changing climate. Since the waning stages of the last great ice age to the present time, climate change has been norm. Generally speaking, climatic conditions on the Colorado Plateau have become progressively warmer and drier throughout this time. However, conditions have also fluctuated dramatically between periods of relative moisture and extended drought. These changes and fluctuations have strongly influenced extremes of river flow and rates of landscape change throughout the region. Continuous measurements of river flow on the Colorado River have only been made for the past 91 years, and this limited record does not provide a sufficient base for predicting the future frequency or magnitude of very large floods.

We also lack much of the basic scientific data that is necessary to understand the complex relationship between the Colorado River and the Moab Valley. We do not have a clear picture of the rate of downcutting of the Colorado River. The many well preserved river terraces both upstream and downstream from Moab valley have not yet been carefully studied, and the ages of these terraces have not been determined. We also lack a clear understanding of the subsidence and filling of Moab Valley. The thickness and extent of the valley filling deposits are only approximately known, particularly on the Moab side of the river. Moreover, the depth of scour within these deposits during very large floods is not well established. More importantly, the ages of these deposits are only very imprecisely known even though several attempts have been made to date them. Therefore, we do not have (and perhaps may never have) sufficient subsurface data to understand anything more than the general details of the dissolution, subsidence, and valley filling processes.

Consequently, we do not know how rapidly the river is eroding downward, how rapidly the valley filling deposits are subsiding, or whether downward erosion and valley subsidence vary in time and space. In short, we have yet to learn very much at all about the natural system that immediately surrounds, supports, and potentially threatens the site of the Atlas tailings pile.

Studies Related to Potential for Catastrophic Flooding

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Among the areas of uncertainty identified by the Draft Environmental Impact Statement (DEIS) for on-site disposal of the mine tailings, that of "Catastrophic Floods" is of particular concern because of the possibility of channel migration into the tailings pile and flood erosion of the tailings. The assumption is made in the DEIS that a catastrophic discharge of 300,000 cubic feet per second will occur no more than once in 500 years. It is also presumed in the DEIS that the much smaller, once-in-100-year flood will reach 3 to 4 feet above the base of the tailings pile. Because these are only estimates, based on extrapolations from very limit stream-gauging data, we will be applying a technique over the next few months to directly test these figures by documentation of actual long-term flood behavior of the Colorado River at Moab.

During several days of field investigations in January of 2005, we identified multiple study sites along the Colorado River that preserve sand and silt deposited by the highest past flood stages of the river. The sites were located by an aerial survey on January 16. The sites include areas near Dewey Bridge and Salt Wash, which are upstream of Moab, and Shafer, Buck and Lathrop Canyons, all of which are downstream of Moab. Several sites were briefly observed from the ground and determined to be appropriate for a subsequent slack-water deposit-paleostage indicator (SWD-PSI) paleoflood hydrology (PFH) investigation. This investigation will occur over the next few months. It will include surveys at each site of elevations, geometry of the adjacent flood channelways, stratigraphy of the flood deposits, geochronology, and hydraulic calculations of the associated paleoflood discharges. The end result will be an estimate of the flood-frequency hazard for the Colorado River in the vicinity of Moab.

Data from the SWD-PSI PFH investigation will form the basis for estimating the potential for flood erosion and inundation of the tailings pile. This potential is critical because of the as-yet-unknown possibility for catastrophic flooding to distribute eroded tailings over the entire inundated region, including much of the city of Moab.

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Figure 1

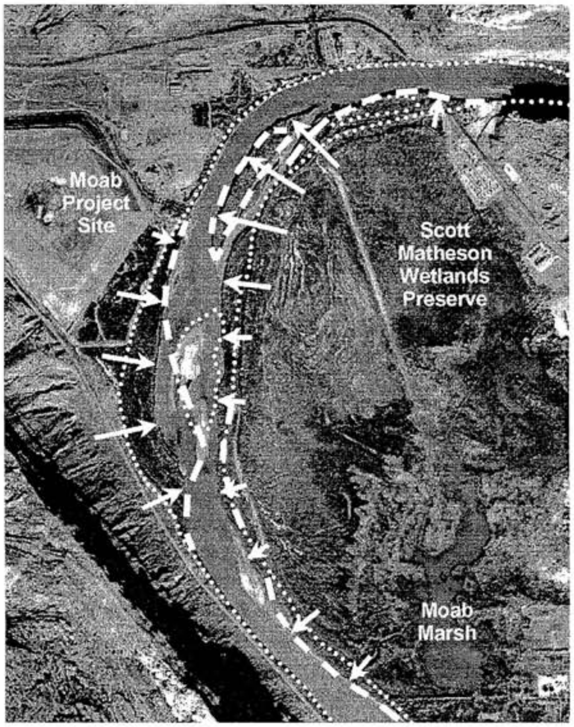

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Figure 2

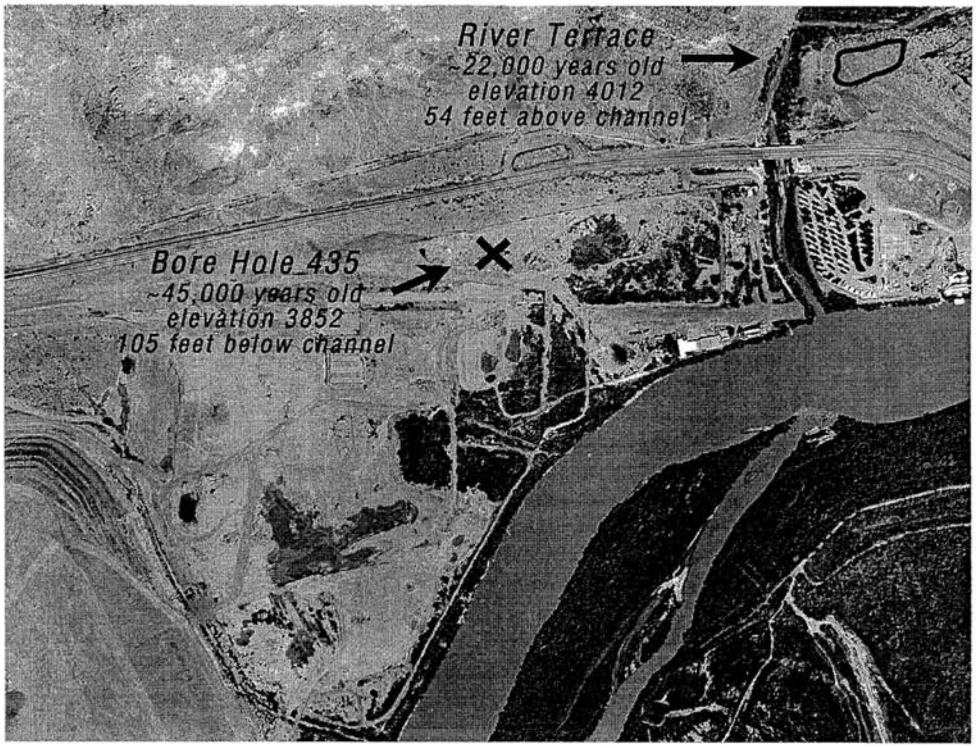

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Figure 3